RS-8410-SCT

DH-0178-14

Final Report

Geohydrological Investigation and Ground Water Monitoring System at Hazardous Waste Impoundment for Lorain Works

United States Steel Corporation
Job No. 02556-187-27

Dames & Moore

Dames & Moore

7101 Wisconsin Avenue, Suite 700
Washington, D.C. 20014
(301) 652-2215
TWX: 710-824-9613 Cable address: DAMEMORE

October 23, 1981

United States Steel Corporation
600 Grant Street
Pittsburgh, Pennsylvania 15230

Attention: Mr. Jack Harper

Re: Final Report
Geohydrological Investigation and
Ground Water Monitoring System
at Hazardous Waste Impoundment for
Lorain Works
United States Steel Corporation (USSC)
Job No. 02556-187-27

Gentlemen:

We are pleased to submit six (6) copies of this report to the United States Steel Corporation (USSC). We have sent two (2) copies to your corporate offices in Pittsburgh, and four (4) copies to the attention of Mr. M. B. White, Lorain Works, Lorain, Ohio.

The report presents the results of our geohydrologic investigation performed at the USSC Lorain Works. Our objectives were to describe the subsurface conditions and hydrology beneath and adjacent to the waste impoundment, to install a ground water monitoring system, and to develop a Sampling and Analysis Plan along with a Ground Water Quality Assessment outline in compliance with the Ohio Environmental Protection Agency (Ohio EPA) and Resource Conservation and Recovery Act (RCRA).

SUMMARY

Our site-specific study included drilling and sampling of six borings, four of which were converted to monitoring wells, to a total depth of 79.8 linear feet. The results of our drilling and testing program indicated that most of the area is overlain by 2 to 4 feet of topsoil or fill. Below the surface layer is approximately 5 to 17 feet of clayey silt or silty clay. Shale bedrock was encountered in three holes.

Four monitoring wells were installed. Wells DM-1 and DM-4 are screened either partially or wholly in the shale. Wells DM-2 and DM-3 are screened in the fill and silty clay layers. The shallowest aquifer was determined to be the silty clay soil and the overlying fill. Since the fill is more permeable than the natural soils or bedrock, migration of contaminants may occur more readily in that layer and it should, therefore, be monitored. The ground water appears to be flowing to the northeast, toward the Black River.

The ground water monitoring system installed at the waste unit consists of one well upgradient and three downgradient along the river. In conjunction with the monitoring system, this report presents a Sampling and Analysis Plan and Ground Water Quality Assessment Plan outline that should bring USSC into compliance with Federal and Ohio EPA monitoring requirements. Dames & Moore will implement the sampling and analysis program, and reporting and statistical activities for the first year, as outlined in our proposal.

It has been a pleasure to work with you on this initial stage of the project. Should you have any questions on the contents of this report or any other aspect of hazardous waste management, do not hestitate to call us.

Respectfully submitted,

DAMES & MOORE

Frank J. Vernese
Associate

Kathryn S. Makeig
Project Manager

FJV/KSM/flc

cc: USSC, Pittsburgh (2)
USSC, Lorain (Attn. M. B. White (4))

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GEOHYDROLOGICAL INVESTIGATION AND
GROUND WATER MONITORING SYSTEM AT
THE HAZARDOUS WASTE IMPOUNDMENT
FOR LORAIN WORKS
UNITED STATES STEEL CORPORATION (USSC)

INTRODUCTION

This report presents the results of our subsurface investigation and ground water monitoring system installation within the United States Steel Corporation (USSC) Lorain Works at Lorain, Ohio (Plate 1). The study focused on the hazardous waste impoundment within the Lorain Works.

The purpose of this investigation was to design and install a ground water monitoring system for the impoundment in compliance with the Resource Conservation and Recovery Act (RCRA) and the Ohio Environmental Protection Agency (Ohio EPA) regulations.

The scope of work included the collection and evaluation of field data to assess subsurface geologic and hydrologic conditions, and the design and installation of a ground water monitoring network for the impoundment. Specifically, the scope of services provided by Dames & Moore for this investigation was as follows:

- Meet with USSC and obtain existing and relevant in-house data.
- Review pertinent regulatory requirements.
- Review files of USSC and Dames & Moore and published information pertaining to the site and waste managements.
- Contract and direct the drilling of four exploratory boreholes used to sample subsurface soils and identify the shallowest aquifer; convert boreholes to monitoring wells.
- Design and direct the installation of a ground water monitoring system for the impoundment in compliance with RCRA and Ohio EPA regulations.

- Contract and direct surveyors to measure the ground surface elevations at boring locations and other relevant locations (river, embankment, etc.).
- Prepare a plan to be used for future ground water quality sampling and analysis.
- Prepare an outline to be used for the ground water quality assessment plan.
- Compile and synthesize the data obtained from our efforts and prepare this report.

Our work was performed in accordance with our letter proposals of June 26 and July 23, 1981, and USSC Purchase Order No. 501-87794-56/355 of September 2, 1981. The scope of services was planned and discussed with Messrs. M. Schack and R. Stinson. During the course of this investigation, we have kept them informed of our progress.

PRELIMINARY STUDY

Dames & Moore conducted a preliminary study to evaluate the need for a ground water monitoring system for the Lorain Works hazardous waste impoundment. The study included a site reconnaissance, an onsite literature review, and a review of the applicable RCRA and Ohio EPA ground water monitoring regulations. Based on the results of this preliminary study, it was concluded that a monitoring variance or waiver at this site would be unlikely. It was therefore agreed that a system would be installed to monitor shallow ground water beneath the impoundment, in compliance with RCRA and Ohio EPA regulations. This preliminary study was completed on January 27, 1981.

FACILITY DESCRIPTION

The hazardous waste impoundment is located within the property boundaries of the Lorain Works, USSC, which border the northeastern limits of the City of Lorain, in north central Lorain County, Ohio. The site occupies the uplands along the Black River Valley, with a land surface elevation ranging from about 580 to 630 feet above mean sea level (MSL).

The Lorain facility subject to RCRA regulations is the hazardous waste impoundment located along the western shore of the Black River. The impoundment is being developed in a crescent-shaped depression confined by the east face of a bluff overlooking the river and a 40-foot high embankment which parallels the river's edge and ties into the bluff.

The crescent-shaped impoundment is about 1,000 feet along its base and approximately 275 feet wide at its widest point. When completed, the facility will cover about 4½ acres. The total capacity is estimated to be 26.0 to 32.6 million gallons. The facility does not have a synthetic liner.

The impoundment receives decanter tar sludge from the coke plant, leaded steel grinder dust from billet preparation, and chromate filter cake, as well as a wide variety of nonhazardous process and construction wastes. The U.S. Environmental Protection Agency (EPA) has determined that decanter tar dust (EPA Identification Number D008), leaded steel (EPA Identification Number K087), and chromate filter cake (EPA Identification Number D007) are toxic due to concentrations of phenol and naphthalene, lead, and hexavalent chromium, respectively.

SUBSURFACE CONDITIONS

The subsurface conditions in the vicinity of the Lorain Works hazardous waste impoundment have been investigated via an exploratory drilling program conducted as part of the monitoring well network design. The locations of these borings are shown on Plate 2. A detailed description of this drilling program and the Logs of Borings are given in Appendix A. Based on our review of the 6 borings drilled for this investigation, subsurface profile section A-A' (Plate 3) was developed. This profile depicts conditions beneath the investigated area and represents an interpretation of the data obtained from the borings. The subsurface conditions between borings were extrapolated from these data and reflect interpreted conditions where no information is available.

Our interpretation indicates that beneath a thin layer (0.5 to 2.0 feet) of topsoil, the upper 3 to 4 feet of material consists of fill of variable composition, including slag, pieces of steel, brick, and wood. No topsoil was encountered in boring DM-4 where the surface was composed of fill material. East-southeast of the impoundment, in borings DM-1 and DM-2, the layer of fill is absent.

Underlying the topsoil or fill (where present) is a 5- to 17-foot zone of soils that grades between clayey silt and silty clay. Beneath this soil zone to the maximum depth explored (21.8 feet) is grey-black shale bedrock. The highly weathered surface of this bedrock appears to dip steeply to the east-northeast with an average slope of 0.08.

The depth to ground water encountered in the borings ranged from 1.3 to 13.8 feet below ground surface, or about +569 to +579 feet above MSL (Table B-1, Appendix B). After the monitoring wells were completed, the piezometric elevations recorded ranged from about +574 to +619 feet or about 3 to 14 feet below ground surface.

GEOHYDROLOGY

The *in situ* horizontal permeabilities of the three zones encountered--slag fill, silty clay, and shale--were investigated in order to determine the most likely path of migration of contaminants. As detailed in Appendix A, constant head permeability tests were conducted in the field during the drilling program. These tests indicate approximate horizontal permeabilities of 6.5×10^{-3} cm/sec for slag fill, 4.8×10^{-4} cm/sec for silty clay, and 2.1×10^{-4} cm/sec for fractures in the shale (Table A-1, Appendix A). The relatively large permeability coefficient for the shale is most likely the result of weathered and fractured zones that create secondary porosity through which ground water can flow. The permeabilities of the silty clay and slag fill materials are within expected values that result from relatively low porosity in the tight silty clay and higher porosity in the void-riddled fill materials.

* Ground water has been encountered in all three layers. The shallowest aquifer has been identified as the fill and silty clay layer, which both appear to be saturated. The results of our field permeability tests indicate that any migration of contaminants most likely would occur through the fill layer. It is also possible that some contaminants could percolate through the silty clay and migrate through fractures in the shale. These zones are both monitored; Wells DM-2 and DM-3 have been screened in the fill and silty clay layers, and Wells DM-1 and DM-4 have been screened either partially or wholly in the shale. Details of the well design and installation procedures are presented in Appendix B.

But no wells develop in both zones

Water level readings indicate that the gradient or dominant direction of ground water flow is northeast, toward the Black River. Three of the wells are located downgradient of the impoundment, between it and the river. Samples from these wells will allow timely detection of any contaminants that may leave the impoundment before they reach the river. The fourth well is located upgradient of the impoundment to provide background water quality samples.

GROUND WATER MONITORING SYSTEM

Current regulations, which are the same under RCRA and Ohio EPA, require that a ground water monitoring system consist of a minimum of four monitoring wells located such that one well is hydraulically upgradient and three wells are hydraulically downgradient of the monitored facility. RCRA and Ohio EPA require that these wells be designed to screen and monitor the shallowest aquifer.

A ground water monitoring system was installed around the impoundment by converting four of the six borings into monitoring wells. The wells comply with RCRA and Ohio EPA regulations and USSC requirements. Details of the well design and installation procedures are presented in Appendix B. Plate 2 shows the locations of the ground water monitoring wells.

SAMPLING AND ANALYSIS PLAN

A sampling and analysis plan is presented in Appendix C. This plan complies with RCRA and Ohio EPA regulations and guidelines.

GROUND WATER QUALITY ASSESSMENT OUTLINE

An assessment outline is presented in Appendix D. This plan complies with RCRA and Ohio EPA regulations and guidelines.

DISCUSSION AND CONCLUSIONS

The results of our drilling and testing program indicate that the uppermost aquifer is the layer of fill and the unit of clayey silt and silty clay. Our testing also indicates that the fractured shale bedrock may provide additional flowpaths for any waste that may be leaving the impoundment. Since all the units appear saturated, the monitoring wells have been designed and screened to intercept ground water flowing through the fill material and silty clay aquifer as well as through fractures in the shale bedrock.

The primary direction of ground water movement and potential contaminant migration is east-northeast, toward the Black River. (The direction and magnitude of this gradient may change in response to local flooding and river levels.) The wells have been located between the impoundment and the river to immediately detect any contaminants leaving the impoundment before they can reach the river.

A ground water monitoring program for all hazardous waste sites is required by RCRA and Ohio EPA regulations. In this program, both the upgradient and downgradient wells must be monitored and evaluated for specific hazardous chemical constituents. A sampling and analysis plan and an assessment outline have been prepared to be used for future ground water quality sampling and assessment, respectively, to reflect this requirement.

The following plates, references, and appendices are attached and complete this report:

Plate 1 - Location of Facility

Plate 2 - Location of Borings and Monitoring Wells

Plate 3 - Subsurface Profile Section A-A'

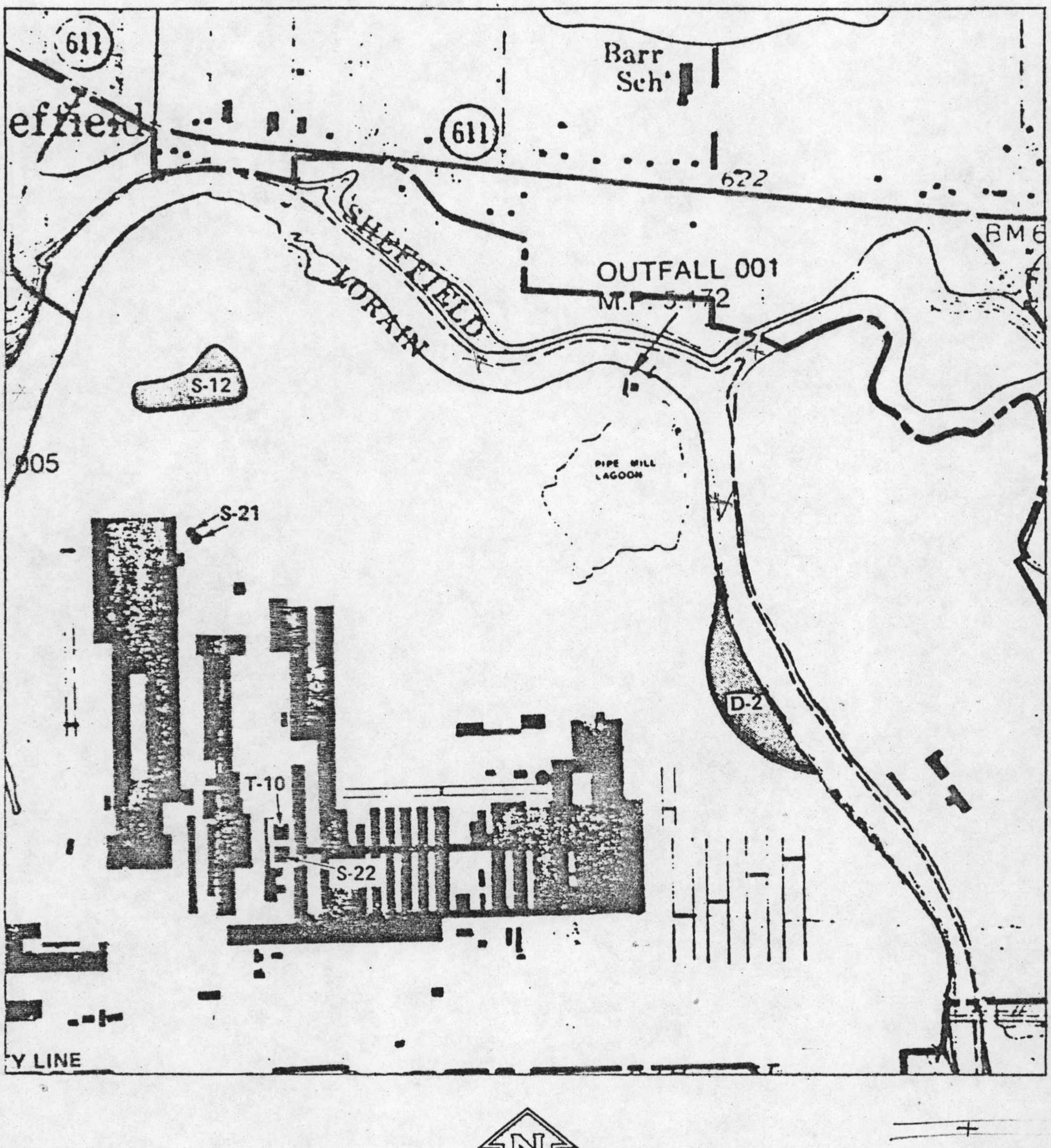
References

Appendix A - Field Exploration and Permeability Testing

Appendix B - Ground Water Monitoring System

Appendix C - Sampling and Analysis Plan

Appendix D - Ground Water Assessment Outline.



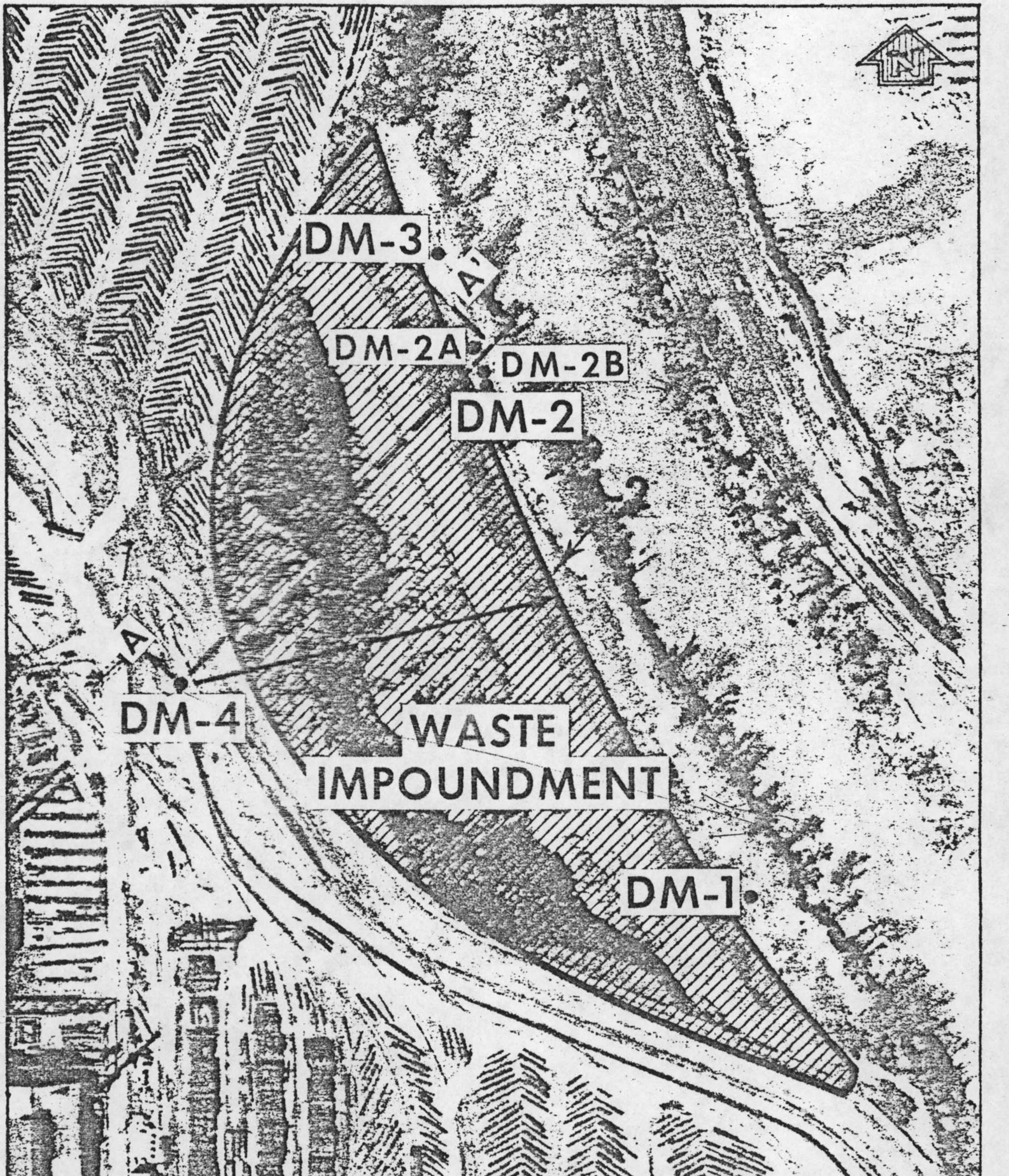
SCALE: 1"=1000'

PLATE 1
SITE AND WASTE IMPOUNDMENT LOCATION
U.S. STEEL CORPORATION
LORAIN PLANT LORAIN, OHIO

LEGEND

D-2 HAZARDOUS WASTE IMPOUNDMENT

DAMES & MOORE



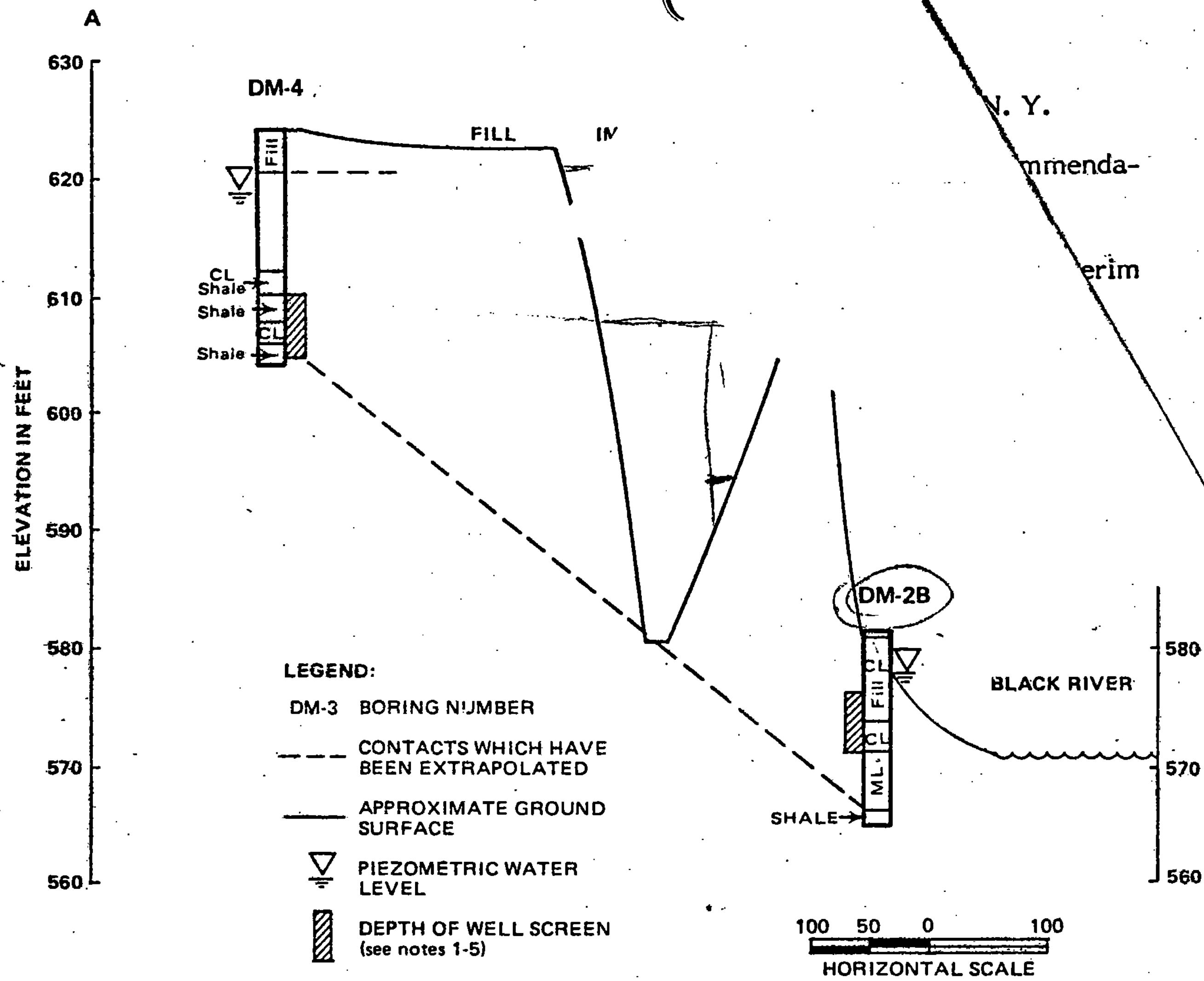
DM-4 ● Boring Drilled and Converted to Monitoring Well During This Investigation in September 1981

A – – – A' Section Profile (See Plate 3)

⟶ Dominant Ground Water Gradient

PLATE 2
LOCATION OF MONITORING WELLS USSC, LORAIN WORKS

DAMES & MOORE



NOTES:

1. The subsurface section line is presented on Plate 2.
2. Elevations of ground surface at boring locations, top of the fill, top of embankment and water surface of Black River were surveyed by Wellert Corporation of Wadsworth, Ohio on October 6, 1981. Otherwise, the representation of the ground surface is approximate.
3. Soil types are classified according to the Unified Soil Classification System.
4. The depth and thickness of the soil strata indicated on the subsurface profile were obtained by interpreting between test borings. Information on actual soil conditions exists only at the test boring locations and it is possible that the soil conditions between the test borings may vary from those indicated.
5. The discussion in the text is necessary for a proper understanding of the nature of the subsurface materials.

PLATE 3
SCHEMATIC
SUBSURFACE PROFILE SECTION A-A'
USSC, LORAIN WORKS

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APPENDIX A

FIELD EXPLORATION AND PERMEABILITY TESTING

APPENDIX A

FIELD EXPLORATION AND PERMEABILITY TESTING

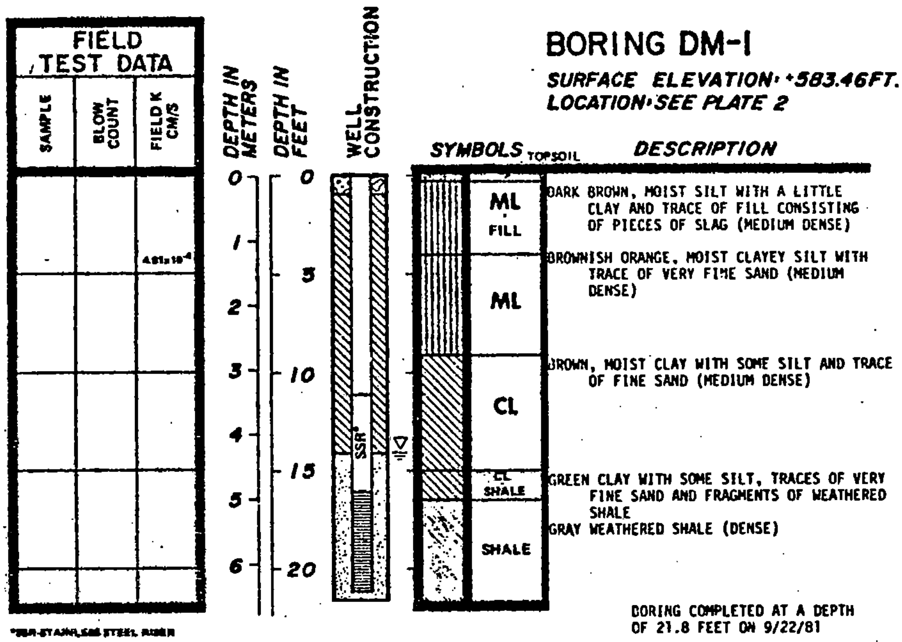
FIELD EXPLORATION

The subsurface soil and ground water conditions that have a bearing on the hazardous waste impoundment located in the USSC Lorain Plant in Lorain, Ohio, were investigated by drilling exploratory test borings between September 22 and September 24, 1981.

Although four borings were originally planned, six borings varying in depth from 3 to 21.8 feet were drilled to obtain data on the subsurface soil profile, ground water hydrology, and the depth of the bedrock surface. Three borings were drilled at the location of DM-2. The first boring could not be advanced below a 3-foot depth because of pieces of steel and other fill materials in the path of the auger. The second, deeper, boring was drilled to 16.3 feet to obtain data on soils, ground water, and depth to bedrock at that location. The third borehole was drilled to 10 feet to allow proper installation of a monitoring well screened in the shallowest aquifer without the uncertainty of grouting a deeper hole or suspending the screen in the hole. Two more borings were drilled east of the impoundment along the Black River at locations DM-1 and DM-3. These boreholes were completed at depths of 21.8 feet in shale bedrock and 8.5 feet in silty clay, respectively. One boring was drilled west of the impoundment and completed in shale bedrock at a depth of 20 feet. The locations of these borings are shown on Plate 2 in the text of this report. Detailed logs of the soil conditions encountered for each test boring are presented on Plates A-1A through A-1 C.

Ground surface elevations shown on the Logs of Borings were surveyed on October 6, 1981, by Wellert Corporation of Wadsworth, Ohio. All of the borings were drilled by Industrial Inspection Industries (III), Inc., of North Canton, Ohio, using dry augering techniques to facilitate investigation of the soil and ground water conditions.

The field operations were performed under the technical control of a Dames & Moore field engineer, who inspected the site, coordinated the drilling operations, maintained a detailed log of each boring, and obtained representative samples of the soils encountered. Representative soil samples were recovered in the borings at intervals noted on the boring logs. These samples are stored at



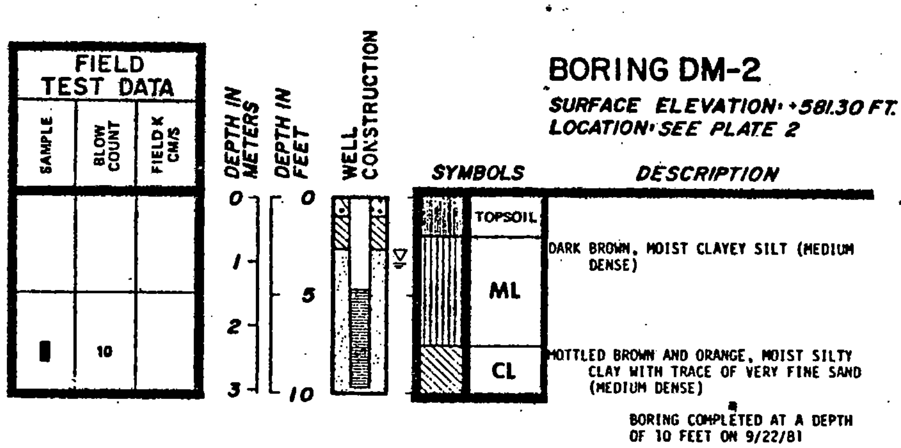
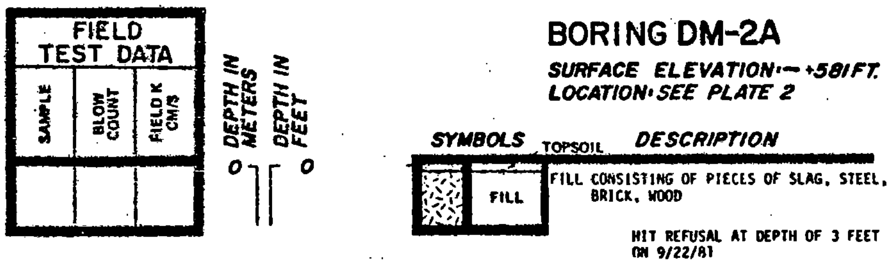


PLATE A-1A
LOG OF BORINGS

BORING DM-2A

SURFACE ELEVATION: ~ +581 FT.
LOCATION: SEE PLATE 2



BORING DM-2B

SURFACE ELEVATION: ~ +581 FT.
LOCATION: SEE PLATE 2

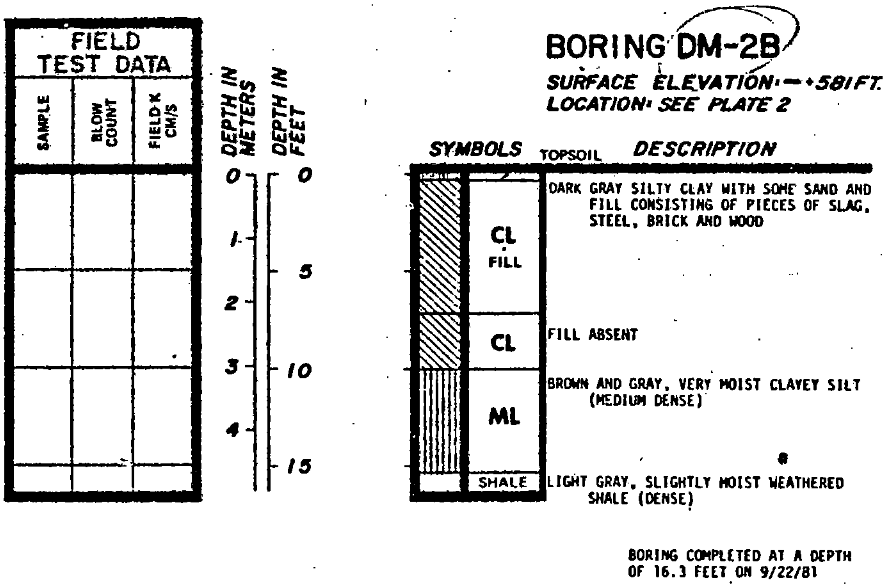
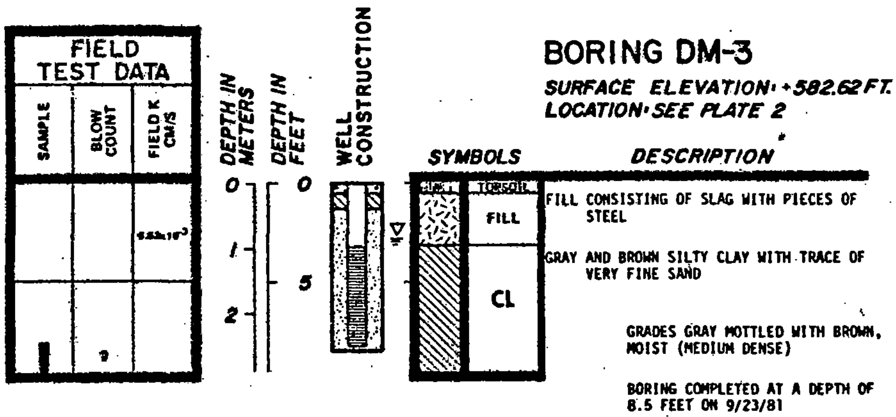


PLATE A-1B
LOG OF BORINGS



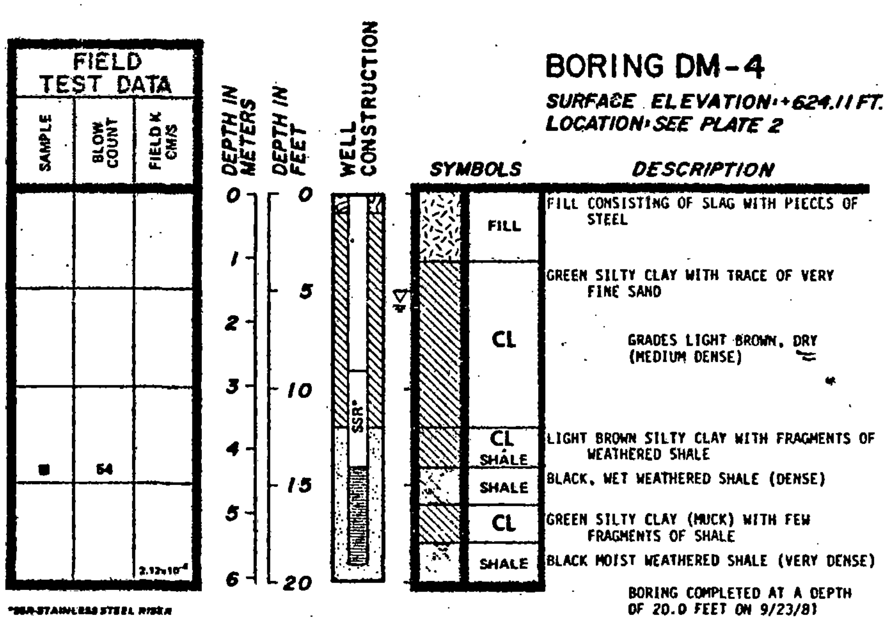


PLATE A-1C
LOG OF BORINGS

Dames & Moore's soil laboratory. Soils were identified and logged in accordance with the Unified Soil Classification System, described on Plate A-2.

PERMEABILITY TESTING

Three constant-head permeability tests were performed in the field in three different types of soil or strata. Table A-1 summarizes the average, in situ horizontal coefficients of permeability for each stratum tested. These results are also shown on the Logs of Borings.

The tests were performed by driving the auger to the desired test interval, washing out the cuttings from inside the auger stem, and filling it with water. A constant pressure head is maintained by adding additional water as needed to keep the water level in the casing constant. The amount of water lost to the formation is recorded as a function of time for approximately 30 minutes. This measurement yields an in situ coefficient of permeability expressed in cm/sec.

The following Table and Plates are attached and complete this appendix:

Table A-1--Summary of Permeability Tests

Plates A-1A through A-1F--Logs of Borings

Plates A-2--Unified Soil Classification System.

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
Coarse Grained Soils More than 50% of Material is *Larger* than No. 200 Sieve Size	**Gravel and Gravelly Soils** More than 50% of Coarse Fraction *Retained* on No. 4 Sieve	**Clean Gravels** Little or No Fines		GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
				GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		Gravels with Fines Appreciable Amount of Fines		GM	Silty Gravels, Gravel-Sand Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand and Sandy Soils More than 50% of Coarse Fraction *Passing* No. 4 Sieve	**Clean Sand** Little or No Fines		SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
				SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		Sands with Fines Appreciable Amount of Fines		SM	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils More than 50% of Material is *Smaller* than No. 200 Sieve Size	**Silts and Clays** Liquid Limit *Less* than 50%			ML	Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
				CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
				OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts and Clays Liquid Limit *Greater* than 50%			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sands or Silty Soils
				CH	Inorganic Clays of High Plasticity, Fat Clays
				OH	Organic Clays of Medium to High Plasticity, Organic Silts
Highly Organic Soils				PT	Peat, Humus, Swamp Soils with High Organic Contents

NOTE: Dual symbols are used to indicate borderline soil classifications

PLATE A-2
UNIFIED SOIL CLASSIFICATION SYSTEM

- A clean sand pack, fine to medium (SP), was placed in the annulus to approximately 2 feet above the slotted screen.
- Peltonite (bentonite) pellets were then dropped into the annulus to form a seal approximately 0.5-foot thick.
- The annular space above the seal was grouted to just below the surface using a mixture of water, bentonite, and cement.
- A thick cement paste block approximately 4-6 inches thick, was placed at the ground surface around the monitoring well.
- USSC agreed to be responsible for placing an acceptable protective device around the top of each well and locking the well caps as necessary.

After installation, the wells were developed by removing water from the monitoring wells. An air compressor was used to pump air through a 1-inch hose into the wells. Air pressure forced groundwater to flow out of the wells. This procedure was continued until all standing water in the well had been evacuated. In order to prevent the transfer of potential contaminants among the wells, the drilling rods and developing equipment were cleaned between wells.

Static piezometric water levels were recorded in the wells at various times after installation. These are shown in Table B-1, Summary of Recorded Piezometric Levels. Water levels were measured from the top of the standing pipe, using a fiberglass tape with a popper. These measurements were recorded to the nearest 1/10 of a foot.

The following Table is attached and completes this Appendix:

Table B-1--Summary of Recorded Piezometric Levels.

APPENDIX B

GROUND WATER MONITORING SYSTEM

A ground water monitoring system was designed and installed during this investigation at the USSC Lorain Works. Under the direct supervision of a Dames & Moore field engineer, monitoring wells were placed in four of the six borings drilled. (The remaining two boreholes were sealed with grout to prevent surface runoff or other contaminants from entering.) The wells were located such that one was hydraulically upgradient and three were hydraulically downgradient from the impoundment to comply with Federal and State regulations. The locations of all monitoring wells are shown on Plate 2 in the text of this report.

The purposes of the ground water monitoring system are to:

- Measure the elevations of the piezometric water surface
- Assess seasonal fluctuations in the piezometric surface
- Define the gradient and direction of slope of the piezometric surface
- Monitor and sample the ground water for chemical analysis.

The installation procedure used for all the monitoring wells was the same. Details of the well construction are shown on the Logs of Borings (Plates A-1A through A-1F). The following sequence of events was followed for each well installation:

- A 10-inch diameter borehole was advanced to the appropriate depth using dry augering technique. No drilling fluid was added.
- A 5-foot length of capped 2-inch diameter stainless steel screen with horizontal slots was installed to the appropriate depth.
- A 5-foot length of unslotted 2-inch diameter stainless steel riser was installed above the screen, using a galvanized iron coupling.
- At locations where the stainless steel riser did not reach ground surface, unslotted 2-inch diameter galvanized black iron pipe was installed from the top of the riser to approximately 3 feet above the ground surface using galvanized iron couplings.
- A vented cap was placed on top of the casing.

APPENDIX B

GROUND WATER MONITORING SYSTEM

TABLE A-1

SUMMARY OF PERMEABILITY TESTS

Boring Number	Depth (feet)	Soil Classification	Average Coefficient of Permeability (cm/sec)*
DM-1	4.0	CL	4.81×10^{-4}
DM-3	3.0	Fill	6.53×10^{-3}
DM-4	20.3	Shale	2.12×10^{-4}

*Horizontal coefficient of permeability.